# ORION 3.1

NMEA User Manual

# CHANGE HISTORY

| Date | Rev | Author | Status | Description of changes |
|---|---|---|---|---|
| 2008-03-25 | 1.00 | AM | Draft | Initial document version |
| 2008-05-06 | 1.01 | AM | Draft | Configuration sections are extended. |
| 2008-07-17 | 1.02 | AM | Draft | Position Pinning Configuration section is updated: zero values for position and velocity thresholds are described. |
| 2008-08-21 | 1.03 | AM | Draft | Position Pinning Configuration section is updated: more usage examples are added, Configuration Sections sections are updated: comment about error responses is added. |
| 2008-08-21 | 1.04 | AM | Draft | Position Pinning Configuration section is updated: pinning position update timeout and deep pinning mode delay are added. |
| 2008-08-26 | 1.05 | AM | Draft | Position Pinning Configuration section is updated: mistakes in examples are fixed |
| 2008-08-27 | 1.06 | AM | Draft | 1. Added note about usage version string as Orion initialization complete signal.<br>2. AGPS custom protocol IDs described in Output Configuration section. |
| 2008-09-02 | 1.07 | AM | Draft | Font size is changed |
| 2008-09-08 | 1.08 | AM | Draft | ”Reset configurations” is not supported for STOP command. |
| 2008-09-19 | 1.09 | AM | Draft | UBP mask description is added to the output configuration |
| 2008-09-23 | 1.10 | AM | Draft | Position Pinning Configuration command update.<br>SLEEP command update.<br>Algorithm Configuration command update.<br>Version Number section update. |
| 2008-10-14 | 1.11 | AM | Draft | Sleep command description is fixed. |
| 2008-10-21 | 1.12 | AM | Draft | Algorithm configuration section is removed |
| 2008-11-07 | 1.13 | AM | Draft | Output Configuration description is updated: new format of UBP mask is described. |
| 2008-11-21 | 1.14 | AM | Draft | - $PUNV,EPH message description is added<br>- $PUNV,GETCONFIG,11 for current status of SBAS functionality is added |
| 2008-12-03 | 1.15 | MV | Draft | - FACTORY reset mask updated. |
| 2008-12-05 | 1.16 | AM | Draft | Typo fix in example in Output Configuration section |
| 2008-12-05 | 1.17 | AM | Draft | SA and APP subsytems are referenced as SAPP |
| 2008-12-22 | 1.18 | AM | Draft | Fix of broken link in section 3.3.11 |
| 2009-01-23 | 1.19 | AM | Draft | Project name is updated |
| 2009-02-13 | 1.20 | AM | Draft | Added clarification on sleep time in Orion |
| 2009-03-02 | 1.21 | AM | Draft | Version string description is fixed |

# REFERENCES


[1] NMEA 0183 Standard For Interfacing Marine Electronic Devices (http://www.nmea.org)

[2] u-Map™ Application Note

[3] u-Nav Binary Protocol Specification for SDK Users, version 2.0

[4] ICD-GPS-200, Revision C

[5] “Atheros MultiMode 3GPP Subsystem Protocol Specification, v1.50”

# ABBREVIATIONS

| Acronym | Description |
|---|---|
| AGPS | Assisted GPS |
| ASCII | American Standard Code for Information Interchange |
| bps | Bits Per Second |
| CRC | Cyclic Redundancy Check |
| FOM | Figure Of Merit |
| FSH | Flash memory |
| GMT | Greenwich Mean Time |
| GPS | Global Positioning System |
| HW | Hardware |
| ID | Identifier |
| LGF | Last Good Fix |
| LSE | Least Square Estimation |
| N/A | Not Applicable |
| NMEA | The National Marine Electronics Association |
| NVRAM | Non Volatile RAM |
| ORION | Atheros brand of GPS receivers |
| PVT | Position-Velocity-Time |
| PRN | Pseudo Random Noise. Identifier for SV. |
| RAIM | Receiver Autonomous Integrity Monitoring |
| RAM | Random Access Memory |
| RF | Radio Frequency |
| RTC | Real Time Clock |
| SAPP | Storable Application Profile Subsystem |
| SAGPS | Self-Assisted GPS |
| SBAS | Satellite Based Augmentation System |
| SDK | Software Development Kit |
| SV | Space Vehicle. Another name for satellite. |
| TCXO | Temperature Controlled Crystal Oscillator |
| TOW | Time Of Week |
| UART | Universal Asynchronous Receiver / Transmitter |
| UBP | u-Nav Binary Protocol |
| UTC | Universal Time Coordinated |
| VSDSP | VLSI Solution DSP |
| WGS84 | World Geodetic System reference frame for the earth, for use in geodesy and navigation |

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# 1 OVERVIEW

This document describes the format and usage of the Atheros custom NMEA messages in the Orion navigation software. It also details the implementation specifics of standard NMEA output messages supported by Orion.

# 2 FORMAT

Atheros custom NMEA messages are structured according to the standard template of NMEA format. Every message starts with a dollar-sign '$'. After this prefix there will be an Atheros command prefix 'PUNV' (not registered) and a comma ',' . After the comma, there is the command field which is defined in section 3. The command field ends with an asterisk '*' and a two digit hexadecimal CRC checksum. The line is executed after <carriage return> <new line> character pair.

Example line: "***$PUNV,<command>*cc<carriage return><new line>***"

Please note all the NMEA messages, which do not start with dollar sign '$' will be ignored without any error response.

## 2.1 CRC Calculation

The CRC calculation is explained in the NMEA standard [1].

If the CRC is omitted or illegal, the message will be rejected. CRC value 'cc' (two lower case c-characters) will always be accepted.

## 2.2 Sentence Termination Delimiter

All sentences end with the sentence termination delimiter <carriage return><new line>. This combination is '\r\n' in C-language format and hexadecimal ASCII values are '$0D_h0A_h$'. Both characters have to be sent after CRC to execute the command.

# 3 CUSTOM NMEA SENTENCES

The command field starts the custom command. Atheros custom NMEA messages are defined below in Table 3-1.

**Table 3-1 Atheros custom NMEA messages**

| Command / Response | In/Out | Description |
|---|---|---|
| ASSIST | In | UTC time assistance input message |
| CORR | In | u-Map assistance message |
| STORELGF | In | Force immediate LGF store operation |
| START | In | Request for immediate restart |
| SLEEP | In | Request to stop the navigation and enter to sleep mode |
| WAKEUP | In | Wake up from sleep |
| STOP | In | Request to stop the navigation |
| CONFIG | In | Request to configure configuration section |
| SET | In | Change configuration in RAM only |
| GETCONFIG | In | Request to read configure information of configuration section |
| VERSION | In | Alias to ***PUNV,GETCONFIG,09*** |
| FOM | Out | Navigation quality indicator (figure-of-merit) |
| CFG_R | Out | Reply message for read configure information |
| CFG_S | Out | Reply message for write configure information |
| ERR | Out | Error message |
| OK | Out | Success message |

If the NMEA string can be decoded to explicit command for the Orion system, the same message will be echoed back to sender.

## 3.1 Timing Limits

The current version of Orion will not operate properly if the user sends more than one custom NMEA message in a second.

## 3.2 Size Limits

According to the NMEA standard the maximum number of characters between the starting delimiter '$' or '!' and the terminating <CR><LF> should be 79, i.e. the maximum needed buffer size should be 82 for one sentence.

For the custom NMEA messages the maximum size of the input messages is 128 characters and for the output messages 200 characters.

## 3.3 Format Description

### 3.3.1 ASSIST

With `ASSIST` command the user can inject time assistance into the navigation software. The format of `ASSIST` command is the following:

**$PUNV,ASSIST,*hhmmss.ss,ddmmyy**cc**

***hhmmss.ss*** is the UTC time: ***hh*** – hours (`00…23`), ***mm*** – minutes (`00…59`), ***ss.ss*** – seconds (`00.00…59.99`)

***ddmmyy*** is the UTC date: ***dd*** – day (`01…31`), ***mm*** – month (`01…12`), ***yy*** – year (`00…99`)

**$PUNV,ASSIST,*tow,wn**cc**

***tow*** is time of the week in milliseconds (`0…604699999`) and ***wn*** is a week number (starting from January 6, 1980)

### 3.3.2 CORR

`CORR` command injects u-Map assistance information into the navigation software. Please find more information about u-Map feature from [2]. The format of `CORR` command is as follows:

**$PUNV,CORR,*hhmmss.sss,llll.llll,N/S,yyyyy.yyyy,E/W,h,h,c,c**cc**

***hhmmss.sss*** is timestamp, which must match the NMEA timestamp from the message set that the correction applies to. The format is: ***hh*** – hours (`00…23`), ***mm*** – minutes (`00…59`), ***ss.sss*** – seconds (`00.000…59.999`)

***llll.llll*** is snapped-to latitude. Degrees-minutes are in decimal format – 2 fixed digits of degrees (`00…90`), 2 fixed digits of minutes (`00…59`) and 4 fixed digits for decimal-fraction of minutes (`0000…9999`). Leading zeros always included for degrees and minutes to maintain fixed length. Trailing zeros always added for decimal-fraction of minutes to maintain fixed length.

***N/S*** is latitude hemisphere: North (***N***) or South (***S***)

***yyyyy.yyyy*** is snapped-to longitude. Degrees-minutes are in decimal format – 3 fixed digits of degrees (`000…180`), 2 fixed digits of minutes (`00…59`) and 4 fixed digits for decimal-fraction of minutes (`0000…9999`). Leading zeros always included for degrees and minutes to maintain fixed length. Trailing zeros always added for decimal-fraction of minutes to maintain fixed length.

***E/W*** is longitude direction, which indicates the longitude direction: East (***E***) or West (***W***).

***h.h*** is heading in degrees (optional). Variable length integer or floating point numeric field. The decimal point and associated decimal fraction are optional. A null field should be used to indicate that no heading assistance is provided.

***c.c*** indicates the degree of confidence of the snapped-to position. Variable length integer or floating point numeric field. The decimal point and associated decimal fraction are optional.

### 3.3.3 STORELGF

With `STORELGF` command the user can force immediate LGF storage

**$PUNV,STORELGF*23**

### 3.3.4 START

With `START` command the user can restart the navigation and erase different kind of data at the same time.

**$PUNV,START,*bitmask**cc**

***bitmask*** is a hexadecimal number (without '`0x`' prefix) specifying the data to be erased

**Table 3-2 Bitmasks**

| Bitmask | Description |
|---|---|
| `0x001` | Erase position from NVRAM, FSH and RAM |
| `0x002` | Erase accurate time, leave inaccurate time |
| `0x004` | Erase RTC time |
| `0x008` | Erase TCXO offset and drift values from NVRAM, FSH and RAM |
| `0x010` | Erase UTC parameters from FSH and RAM |
| `0x020` | Erase ionospheric correction parameters from FSH and RAM |
| `0x040` | Erase all almanacs from FSH and RAM |
| `0x080` | Erase NVRAM |
| `0x100` | Reset configurations from FSH and RAM (Output, Zone, Debug, Datum, VSDSP, pinning) |
| `0x200` | Erase all ephemerides from FSH and RAM |
| `0x400` | Erase all prehistory information collected so far in FSH and RAM |

There is a number of predefined mnemonics to be used with the `START` command. When alias is used the command has the following form:

**$PUNV,START,*alias**cc**

***alias*** is a mnemonic specifying the particular bitmask

**Table 3-3 Aliases**

| Alias | Bitmask | Description |
|---|---|---|
| FACTORY | 0xFF7F | Start-up with no prior information and reset configuration (FSH and RAM) to compiled–in factory defaults |
| ALL | 0x02FF | Erase everything else except configurations |
| COLD | 0x02F7 | Retain TCXO and configurations |
| LGFCOLD | 0x02F6 | Retain TCXO, position and configurations |
| WARM | 0x0202 | Retain TCXO, position, RTC time and configurations |
| NOTIME | 0x0004 | Erase time, retain everything else |
| MEDIUM | 0x0002 | Erase time, but leave RTC |
| HOT | 0x0000 | Do not erase anything |
| AUTO | 0x0000 | Do not erase anything |

START command in its simplest form is also supported:

**$PUNV,START*71**

, which just restarts navigation without erasing anything. So effectively it is equal to

**$PUNV,START,HOT*0E**

and

**$PUNV,START,AUTO*52**

and

**$PUNV,START,0*6D**

commands

### 3.3.5 SLEEP

With the SLEEP command the user can put the system into the sleep mode. The system stays in the sleep mode until it is forced to wake up by activity on UART0 or after specified timeout. The NMEA command for the sleep mode without timeout is

**$PUNV,SLEEP,*bitmask**cc**

***bitmask*** is a hexadecimal number (without '0x' prefix) specifying the data to be erased and has the same set of possible values as for START command described in 3.3.4

SLEEP command in its simplest form is also supported:

**$PUNV,SLEEP*7E**

, which effectively equals to

**$PUNV,SLEEP,0*62**

The NMEA command for sleep mode for a predefined time has the following form:

**$PUNV,SLEEP,*hh*,*mm*,*ss**cc**

***hh*** is hours (00…24)

***mm*** is minutes (00…59)

***ss*** is seconds (00…59).

The total sleeping time specified should be less than 90000 seconds.

Please note that specified sleep time determines exactly the period of time, when power consumption of single-chip GPS receiver stays low. If measuring sleep time by watching NMEA stream, it might be several seconds longer due to processing overhead in Orion related to messages processing, UART queue flushing delays etc.

### 3.3.6 WAKEUP

To wake up from sleep, send any kind of NMEA message to UART0 port. The content of this message is disregarded by the system. After the wakeup from sleep, the system is always started in auto mode just like if `$PUNV,START,AUTO*52` command was sent. For distinctness sake the following command can be used

**$PUNV,WAKEUP*2C**

### 3.3.7 STOP

With `STOP` command the user can stop the navigation and erase different kind of data at the same time.

**$PUNV,STOP,*bitmask**cc**

***bitmask*** is a hexadecimal number (without '`0x`' prefix) specifying the data to be erased. It has the same set of possible values as for `START` command described in 3.3.4. The exception is "Reset Configurations from FSH and RAM", which should not be used with `STOP` command.

There is a number of predefined mnemonics to be used with the `STOP` command. When alias is used the command has the following form:

**$PUNV,STOP,*alias**cc**

***alias*** is a mnemonic specifying the particular bitmask. It has the same set of possible values as for `START` command described in 3.3.4. The only exceptions are `FACTORY`, `HOT` and `AUTO` aliases, which are not supported for `STOP` command.

`STOP` command in its simplest form is also supported:

**$PUNV,STOP*29**

, which just stops navigation without erasing anything. So effectively it is equal to

**$PUNV,STOP,0*35**

Please note that the confirmation for `STOP` command will be echoed only after the system has stopped. Until that Orion will produce navigation data.

### 3.3.8 CONFIG

With `CONFIG` command the user can change the configuration of the system. The configuration takes effect immediately and it is also stored in non-volatile media. The format of `CONFIG` command is the following:

**$PUNV,CONFIG,*section ID*,*Various number of comma separated fields**cc**

***section ID*** is a decimal number specifying the section ID. It is 2 fixed decimal digits and leading zeros are mandatory.

Reply to this command is `CFG_S` sentence described in 3.3.16

### 3.3.9 SET

With `SET` command the user can change the configuration of the system. The configuration takes effect immediately, but the new configuration is not stored in non-volatile media. The format of `SET` command is the following:

**$PUNV,SET,*section ID*,*Various number of comma separated fields**cc**

***section ID*** is a decimal number specifying the section ID. It is two fixed decimal digits and leading zeros are mandatory.

### 3.3.10 GETCONFIG

By `GETCONFIG` command the user can read the configuration of the system. The format of this message is as follows:

**$PUNV,GETCONFIG,*section ID**cc**

***section ID*** is a decimal number specifying the section ID. It is two fixed decimal digits and leading zeros are mandatory.

Reply to this command is `CFG_R` sentence described in 3.3.13

### 3.3.11 VERSION

By `VERSION` command the user can read version number string. The format of this message is as follows:

**$PUNV,VERSION*6B**

The reply to this command is `CFG_R` sentence described in 3.4.3

This command is an alias to the command

**$PUNV,GETCONFIG,09*48**

### 3.3.12 FOM

This message is navigation (PVT) quality indicator, i.e. figure-of-merit. It has the following format:

**$PUNV,FOM,*fom**cc**

***fom*** a floating point number (`.000....999`).

Please see section 3.4.1 describing the way how this message can be enabled.

### 3.3.13 EPH 1,2,3

It is an ephemeris message, which contains the ephemeris data for one PRN and the internal status (validity) of ephemeris and almanac for all PRN's. Please refer to [4] for ephemeris data detailed description. The EPH message is used by the SAGPS function to collect live ephemeris data for use in its prediction algorithm. Three EPH messages are required to send the data for one PRN. The format of the messages is as follows:

**$PUNV,EPH,1,*SS*,*EphMask*,*AlmMask*,*SF1_3*,*SF1_7*,*SF1_8*,*SF1_9*,*SF1_10**cc**

**$PUNV,EPH,2,*SS*,*SF2_3*,*SF2_4*,*SF2_5*,*SF2_6*,*SF2_7*,*SF2_8*,*SF2_9*,*SF2_10**cc**

**$PUNV,EPH,3,*SS*,*SF3_3*,*SF3_4*,*SF3_5*,*SF3_6*,*SF3_7*,*SF3_8*,*SF3_9*,*SF3_10**cc**

***SS*** is the PRN number (1…32)

***EphMask*** indicates if Orion has valid ephemeris for particular PRN. ***EphMask*** of 0A050301 means that Orion has valid ephemeris for PRN's 28, 26, 19, 17, 10, 9, and 1.

NOTE: Any ephemeris from a predicted process (SAGPS or whatever) will have its associated mask value cleared. For example, in the ***$PUNV,EPH,1,01,0A050300,...*** the one can see that this data is for PRN 1, however the mask value for PRN 1 is 0. Therefore this should not be used by the prediction process.

***AlmMask*** indicates if Orion has valid almanac for particular PRN. ***AlmMask*** of FFFFFFFE means we have valid almanac for all satellites except PRN 1.

Each sub-frame word in the message format is designated as ***SFx_y***, where x - sub-frame number (1, 2, or 3) and y - word number in sub-frame (1-10).

***SF1_3[23:14]*** – Week No.: ephemeris reference week number [9:0]

***SF1_3[7:2]*** - SV health: transmitting satellite health [5:0]

***SF1_3[1:0]*** – IODC: Issue Of Data, Clock [9:8]

***SF1_7[7:0]*** – $T_{GD}$: Estimated Group Delay Differential (sec) [7:0]

***SF1_8[23:16]*** – IODC: Issue Of Data, Clock [7:0]

***SF1_8[15:0]*** – $t_{oc}$: Clock Data Reference Time (16 sec) [15:0]

***SF1_9[23:16]*** - $a_{f2}$: SV Clock Correction (sec/sec$^2$) [7:0]

***SF1_9[15:0]*** - $a_{f1}$: SV Clock Correction: (sec/sec) [15:0]

***SF1_10[23:2]*** - $a_{f0}$: SV Clock Correction: (sec) [21:0]

***SF2_3[23:16]*** – IODE: Issue Of Data, Ephemeris [7:0]

***SF2_3 [15:0]*** – $C_{rs}$: Amplitude of the Sine Harmonic Correction Term to the Orbit Radius (meters) [15:0]

***SF2_4[23:8]*** – $\Delta$n: Mean Motion Difference From Computed Value (semi-circles/sec) [15:0]

***SF2_4[7:0]*** – $M_0$: Mean Anomaly at Reference Time (semi-circles) [31:24]

***SF2_5[23:0]*** - $M_0$: Mean Anomaly at Reference Time (semi-circles) [23:0]

***SF2_6[23:8]*** – $C_{uc}$: Amplitude of the Cosine Harmonic Correction Term to the Argument of Latitude (radians) [15:0]

***SF2_6[7:0]*** – e: Eccentricity [31:24]

***SF2_7[23:0]*** – e: Eccentricity [23:0]

***SF2_8[23:8]*** – $C_{us}$: Amplitude of the Sine Harmonic Correction Term to the Argument of Latitude (radians) [15:0]

***SF2_8[7:0]*** – $(A)^{1/2}$: Square Root of the Semi-Major Axis ($m^{½}$) [31:24]

***SF2_9[23:0]*** – $(A)^{1/2}$: Square Root of the Semi-Major Axis ($m^{½}$) [23:0]

***SF2_10[23:8]*** – $t_{oe}$: Reference Time Ephemeris (16 sec) [15:0]

***SF2_10[7]*** – Fit: Curve fit interval flag [0]

***SF3_3[23:8]*** – $C_{ic}$: Amplitude of the Cosine Harmonic Correction Term to the Angle of Inclination (radians) [15:0]

***SF3_3[7:0]*** – $(OMEGA)_0$: Longitude of Ascending Node of Orbit Plane at Weekly Epoch (semi-circles) [31:24]

***SF3_4[23:0]*** - $(OMEGA)_0$: Longitude of Ascending Node of Orbit Plane at Weekly Epoch (semi-circles) [23:0]

***SF3_5[23:8]*** - $C_{is}$: Amplitude of the Sine Harmonic Correction Term to the Angle of Inclination (radians) [15:0]

***SF3_5[7:0]*** - $i_0$: Inclination Angle at Reference Time (semi-circles) [31:24]

***SF3_6[23:0]*** – $i_0$: Inclination Angle at Reference Time (semi-circles) [23:0]

***SF3_7[23:8]*** - $C_{rc}$: Amplitude of the Cosine Harmonic Correction Term to the Orbit Radius (meters) [15:0]

***SF3_7[7:0]*** – ω: Argument of Perigee (semi-circles) [31:24]

***SF3_8[23:0]*** – ω: Argument of Perigee (semi-circles) [23:0]

***SF3_9[23:0]*** – OMEGADOT: Rate of Right Ascension (semi-circles/sec) [23:0]

***SF3_10[23:16]*** – IODE: Issue Of Data, Ephemeris [7:0]

***SF3_10[15:2]*** – IDOT: Rate of Inclination Angle (semi-circles/sec) [13:0]

The ephemeris data in EPH messages is formatted as sub-frame words in hexadecimal encoding with LSB on the right side. Fixed length (6 hexadecimal digits) is used for ***SFx_y*** fields (***SF1_3***, ***SF1_7*** … are just placeholders for the sub-frame words), because each 30 bit sub-frame word from the satellite contains only 24 bits of data (6 parity bits). Since the sub-frame words are generated from decoded and verified ephemeris data no parity information is included. Therefore each word contains 24 bits of sub-frame data.

Example:

***SF1_9*** field: contains $a_{f2}$ (8 bits) and $a_{f1}$ (16 bits terms). If $a_{f2}$ = 0x11 and $a_{f1}$ = 0x5555, then the ***SF1_9*** field would be 115555.

Note that no data is transmitted for ***SFx_1*** or ***SFx_2*** (TOW and Handover words) or for ***SF1_4***, ***SF1_5*** or ***SF1_6*** (unusable reserve data + L2P flag (also not used)).

### 3.3.14 EPH 0

To facilitate detection of the need for ephemeris the EPH message with only the mask values will come out when the ephemeris mask is 0. When the ***EphMask*** is non-zero the normal 3 message set will come out. The ***AlmMask*** may or may not be zero.

**$PUNV,EPH,0,*EphMask*,*AlmMask**cc**

Please see section 3.3.13 for description of ***EphMask*** and ***AlmMask*** fields in this message.

This message is generated when no ephemeris is valid.

### 3.3.15 CFG_R

CFG_R sentence is a reply message for request of reading configuration. This NMEA message contains all configuration information about the selected section.

**$PUNV,CFG_R,*section ID*,*Comma separated list of parameters in selected section**cc**

***section ID*** is a decimal number specifying the section ID. It is two fixed decimal digits with leading zeros if necessary.

### 3.3.16 CFG_S

CFG_S sentence is a reply message for request of changing configuration by ***$PUNV,CONFIG*** command. The format of the message is as follows.

**$PUNV,CFG_S,*section ID**cc**

***section ID*** is a decimal number specifying the modified section ID. It is two fixed decimal digits with leading zeros if necessary.

This reply message is sent when configuration data is already successfully stored into non-volatile memory (flash).

### 3.3.17 ERR

ERR is a reply message of an error in the system. The format of the message is as follows:

**$PUNV,ERR,*ID*,*error*,*data**cc**

***ID*** is the ID of subsystem, which detected the error. Two decimal digits with leading zero if necessary.

***error*** is the subsystem specific error number. Five decimal digits with leading zero if necessary.

***data*** is the error specific optional data. Five decimal digits with leading zero if necessary.

This document describes only those error codes that occur with NMEA commands.

**Table 3-4. Error codes**

| ID | Subsystem | error | data | Description |
|---|---|---|---|---|
| 4 | AGPS | message ID | sub-code* | AGPS message processing error. Message ID in the error code field specifies which message processing is failed. Please see [5] for detailed description of supported AGPS messages. |
| 5 | NMEA | 1 | 0 | Illegal command form |
| 5 | NMEA | 2 | 0 | Illegal command prefix |
| 5 | NMEA | 3 | 0 | Illegal command |
| 5 | NMEA | 4 | 0 | Illegal section ID |
| 5 | NMEA | 5 | 0 | Illegal parameter |

| ID | Subsystem | error | data | Description |
|---|---|---|---|---|
| 5 | NMEA | 6 | 0 | Illegal CRC |
| 5 | NMEA | 7 | 0 | Illegal message |
| 7 | SAPP | 1 | sub-code* | Reading file data: file open operation is failed |
| 7 | SAPP | 2 | sub-code* | Reading file data: file seek operation is failed |
| 7 | SAPP | 3 | sub-code* | Reading file data: file read operation is failed |
| 7 | SAPP | 4 | sub-code* | Reading file data: file close operation is failed |
| 7 | SAPP | 5 | sub-code* | Reading file data: get file size operation is failed |
| 7 | SAPP | 6 | sub-code* | Writing data to file: file open operation is failed |
| 7 | SAPP | 7 | sub-code* | Filling data into file: file seek operation is failed |
| 7 | SAPP | 8 | sub-code* | Filling data into file: file write operation is failed |
| 7 | SAPP | 9 | sub-code* | Writing data to file: file seek operation is failed |
| 7 | SAPP | 10 | sub-code* | Writing data to file: file write operation is failed |
| 7 | SAPP | 11 | sub-code* | Writing data to file: file close operation is failed |
| 7 | SAPP | 12 | sub-code* | Memory allocation failed |
| 7 | SAPP | 13 | sub-code* | Incoming request is rejected |
| 7 | SAPP | 14 | sub-code* | Error detected in the incoming request. Possible reason is the store request for incorrect data. |
| 7 | SAPP | 15 | sub-code* | Erase file operation failed |
| 7 | SAPP | 16 | sub-code* | Illegal configuration data is detected in the flash. Possible reason is incorrect start-up values set by SDK user. |

* sub-code is used for detailed description of error. It is implementation specific code.

Examples of error messages:

Illegal CRC:

***$PUNV,ERR,05,00006,00000*5B***

Illegal command:

***$PUNV,ERR,05,00003,00000*5E***

### 3.3.18 OK

OK is an acknowledgement message, which is sent as reply of successful execution of command, sent via different protocol. Currently OK is sent to confirm successful execution of commands sent via AGPS protocol. The format of the message is as follows:

**$PUNV,OK,*ID*,*message ID**cc**

***ID*** is the ID of responding navigation subsystem. Two decimal digits with leading zero if necessary.

***message ID*** is the ID of successfully executed command. Five decimal digits with leading zeros if necessary.

## 3.4 Configuration Sections

### 3.4.1 Output Configuration

Output configuration is used to configure input/output protocol.

The current output configuration can be read in the system with the following command:

**$PUNV,GETCONFIG,00*41**

The answer is as follows:

**$PUNV,CFG_R,00,*CM-OutCM-In*,0,1000,*UART*,*NMEA_MASK**cc**

The configuration command template for output configuration is as follows:

**$PUNV,CONFIG,00,*CM-OutCM-In*,0,1000,*UART*,*NMEA_MASK/UBP_MASK**cc**

or

**$PUNV,SET,00,*CM-OutCM-In*,0,1000,*UART*,*NMEA_MASK/UBP_MASK**cc**

**Table 3-5 Output configuration**

| Name | Format | Valid values | Default value | Description |
|---|---|---|---|---|
| ***CM-In*** | Two hexadecimal digits | 00 – NMEA<br>01 – UBP<br>04 – AGPS 3GPP<br>05 – AGPS 3GPP2<br>09 – AGPS custom<br>10 – User specific | 00 - NMEA | Input communication protocol |
| ***CM-Out*** | Two hexadecimal digits | 00 – NMEA<br>01 – UBP<br>04 – AGPS 3GPP<br>05 – AGPS 3GPP2<br>09 – AGPS custom<br>10 – User specific | 00- NMEA | Output communication protocol |
| ***UART*** | Decimal | 300,1200,2400,4800,<br>9600,14400,19200,<br>28800,57600,115200 | 4800 | UART communication speed (bps) |

| Name | Format | Valid values | Default value | Description |
|---|---|---|---|---|
| ***NMEA_MASK*** | Three hexadecimal digits | 001 – GGA<br>002 – GLL<br>004 – GSA<br>008 – GSV<br>010 – RMC<br>020 – VTG<br>040 – ZDA<br>080 – DTM<br>100 – FOM<br>200 – EPH | 01D | NMEA mask. It is a hexadecimal number that enables selected output NMEA messages. Different combinations of the outputting messages can be selected by calculating the final hexadecimal number after adding all wanted hexadecimal masks together. FOM message is described in section 3.3.12 and EPH message is described in sections 3.3.13 and 3.3.14. |
| ***UBP_MASK*** | List of eight hexadecimal digits separated by commas | Please see [3] for possible UBP messages' ID codes | N/A | Comma separated list of hexadecimal UBP message IDs, which are sent out by UART. The maximum number of IDs in the list is limited by the maximum size of custom NMEA sentence, which is 128 characters. A special encoding is used to represent UBP messages in the list: Each entry encoded by up to eight hexadecimal digits. The least significant word is a base UBP message ID. The most significant word is a bit mask representing up to 16 UBP messages: bit 16 represents UBP message with ID = (base UBP message ID + 1), bit 17 represents UBP message with ID = (base UBP message ID + 2) and so on. Therefore one 32 bit word can encode up to 17 UBP message IDs.<br>For example,<br>UBP list entry 0x80010201 encodes UBP messages 0x201, 0x202 and 0x211. |

Note! If the user changes the input communication protocol to other than NMEA, then to return to NMEA as an input protocol the new protocol specific command should be used.

Please note that there is no comma or space between CM-Out and CM-In fields.

The application profile subsystem will check the maximum length of the NMEA messages when changing output section. For example, if the speed is set to 4800 bps, the output protocol is NMEA and the selected NMEA messages will take bandwidth more than 450 characters per second, the application profile subsystem will produce an error message and reject the changes.

In case of successful execution of

**$PUNV,CONFIG,00,*CM-OutCM-In*,0,1000,*UART*,*NMEA_MASK*/*UBP_MASK***cc**

command the receiver sends confirmation in a following form:

**$PUNV,CFG_S,00*53**

In case of failure of execution of GETCONFIG, CONFIG or SET command the receiver sends ERR reply message. Please see ERR section for details.

Examples:

To produce all other messages but EPH, DTM and FOM at the speed of 115200 bps:

***$PUNV,CONFIG,00,0000,0,1000,115200,7F*cc***

To disable the default NMEA messages:

***$PUNV,CONFIG,00,0000,0,1000,4800,0*cc***

### 3.4.2 Time Zone Configuration

Time Zone configuration is used to configure user localization data.

The current configuration can be read in the system by the following command:

**$PUNV,GETCONFIG,03*42**

The answer is as follows:

**$PUNV,CFG_R,03,*HZ*,*MZ**cc**

The configuration command template for the Time Zone configuration is

**$PUNV,CONFIG,03,*HZ*,*MZ**cc**

or

**$PUNV,SET,03,*HZ*,*MZ**cc**

**Table 3-6 Time zone configuration**

| Name | Format | Valid values | Default value | Description |
|---|---|---|---|---|
| ***HZ*** | Decimal | -11,-10,-9,...,12<br>999 (not set) | 999 | Hour zone. It is an amount of full hour difference from the GMT. |
| ***MZ*** | Decimal | 0,15,30,45<br>999 (not set) | 999 | Minute zone. It is an amount of extra minutes over the full hours. |

In case of successful execution of

**$PUNV,CONFIG,03,*HZ*,*MZ**cc**

command the receiver sends confirmation in a following form:

**$PUNV,CFG_S,03*50**

In case of failure of execution of GETCONFIG, CONFIG or SET command the receiver sends ERR reply message. Please see ERR section for details.

Examples:

To set the −8 hour time zone:

***$PUNV,CONFIG,03,-8,0*31***

### 3.4.3 Version Number

Version configuration is used to deliver system version numbers. If output protocol is NMEA, then version numbers message is also reported after power-on, any commanded start command described in 3.3.4 section and after exiting sleep mode. In this case version numbers message is used for notification that Orion's initialization sequence is complete and it is ready to accept commands.

The version numbers can be read by using the following command:

**$PUNV,GETCONFIG,09*48**

The answer is as follows:

**$PUNV,CFG_R,09,*Orion*,*UBP*,*BB*,*Flash*,*DeviceID*,*RF-mode*,*RF-CS*,*TCXO-PPB*,*TCXO-Freq**cc**

***Orion*** is the Orion version string

***UBP*** is the UBP version number

***BB*** is the baseband type

***Flash*** is the flash type

***DeviceID*** is the device identifier (hexadecimal number)

***RF-mode*** is RF chip mode (these changed by the a SDK user)

***RF-CS*** is RF IC chip select (these can be changed by a SDK user)

***TCXO-PPB*** is the TCXO uncertainty (this can be changed by a SDK user)

***TCXO-Freq*** is the TCXO frequency (this can be changed by a SDK user)

In case of failure of execution of this command the receiver sends ERR reply message. Please see ERR section for details.

### 3.4.4 SBAS Configuration

SBAS configuration is used to configure SBAS functionality.

The current SBAS configuration can be read in the system with the following command:

**$PUNV,GETCONFIG,11*41**

The answer is as follows:

**$PUNV,CFG_R,11,*Sbas*,*X*,*X*,*X*,*X*,*X*,*X*,*X*,*X*,*X*,*X*,*X*,*X*,*X*,*X*,*X*,*X*,*X**cc**

**Table 3-7 SBAS configuration**

| Name | Format | Valid values | Default value | Description |
|---|---|---|---|---|
| ***Sbas*** | Decimal number | 0,1 | 1 | SBAS master control:<br>0 - SBAS is switched off,<br>1 - SBAS is switched on. |
| ***X*** | N/A | N/A | N/A | N/A |

SBAS functionality can be switched on or off by following command

**$PUNV,CONFIG,SBAS,*Status**cc**

or

**$PUNV,SET,SBAS,*Status**cc**

**Table 3-8 SBAS configuration**

| Name | Format | Valid values | Default value | Description |
|---|---|---|---|---|
| ***Status*** | String | ON, OFF | ON | SBAS status:<br>ON – SBAS is switched on,<br>OFF- SBAS is switched off. |

In case of successful execution of

**$PUNV,CONFIG,SBAS,*Status**cc**

command, the receiver sends confirmation in a following form:

**$PUNV,CFG_S,11*53**

In case of failure of execution of GETCONFIG, CONFIG or SET command the receiver sends ERR reply message. Please see ERR section for details.

### 3.4.5 Datum Configuration

Datum configuration is used to select the output datum.

The current configuration can be read in the system by the following command:

**$PUNV,GETCONFIG,13*43**

The answer is as follows:

**$PUNV,CFG_R,13,*Dx*,*Dy*,*Dz*,*Da*,*Df*,*Name*,*Id**cc**

The configuration command template for custom datum is as follows:

**$PUNV,CONFIG,13,*Dx*,*Dy*,*Dz*,*Da*,*Df*,*Name**cc**<CR><LF>**

or

**$PUNV,SET,13,*Dx*,*Dy*,*Dz*,*Da*,*Df*,*Name**cc**<CR><LF>**

To select one of the predefined data, the syntax is as follows:

**$PUNV,CONFIG,16,*Id**cc**<CR><LF>**

or

**$PUNV,SET,16,*Id**cc**<CR><LF>**

**Table 3-9 Datum configuration**

| Name | Format | Valid values | Default value | Description |
|---|---|---|---|---|
| ***Dx*** | Decimal | $-2^{15}-1 \ldots 2^{15}-1$ | 0 | Datum centre X shift in respect to WGS84 ellipsoid (in meters). |
| ***Dy*** | Decimal | $-2^{15}-1 \ldots 2^{15}-1$ | 0 | Datum centre Y shift in respect to WGS84 ellipsoid (in meters). |
| ***Dz*** | Decimal | $-2^{15}-1 \ldots 2^{15}-1$ | 0 | Datum centre Z shift in respect to WGS84 ellipsoid (in meters). |
| ***Da*** | Decimal with fractional part | >0 | 6378137 | Datum semi-major axis (in meters). |
| ***Df*** | Fractional decimal | 0…1 | 0.003352810664 | Flattening of datum. |
| ***Name*** | String up to 8 characters long | Please see Appendix A - Datum codes for possible datum names. | WGS84 | The name of the selected datum. |
| ***Id*** | Decimal | Please see Appendix A - Datum codes for possible ID numbers. | 1 | Identifier of a pre-defined datum. |

In case of successful execution of

**$PUNV,CONFIG,13,*Dx*,*Dy*,*Dz*,*Da*,*Df*,*Name**cc**<CR><LF>**

and

**$PUNV,CONFIG,16,*Id**cc**<CR><LF>**

commands the receiver sends confirmation in a following form:

**$PUNV,CFG_S,13*51<CR><LF>**

In case of failure of execution of GETCONFIG, CONFIG or SET command the receiver sends ERR reply message. Please see ERR section for details.

Examples:

Default settings:

***$PUNV,CONFIG,16,1*0D***

### 3.4.6 Position Pinning Configuration

Position pinning configuration is for static case parameter configuration.

The current configuration can be read in the system by the following command:

**$PUNV,GETCONFIG,17*47**

The answer is as follows:

**$PUNV,CFG_R,17,*Position threshold*,*Velocity threshold*,*Position update timeout*,*Deep mode delay*,*2D reacquisition 2D all 2D cold* *cc**

The configuration command template for control configuration is as follows:

**$PUNV,CONFIG,17,*Position threshold*,*Velocity threshold*, *Position update timeout*,*Deep mode delay*,*2D reacquisition 2D all 2D cold**cc**

or

**$PUNV,SET,17,*Position threshold*,*Velocity threshold*,*2D reacquisition 2D all 2D cold**cc**

**Table 3-10 Position pinning parameters**

| Name | Format | Valid values | Default value | Description |
|---|---|---|---|---|
| ***Position threshold*** | Decimal with fractional part | ≥0 | 50 | The threshold value for position jump. Position pinning will be disabled if this value is reached (in meters). Zero values for position and velocity thresholds effectively mean that position pinning is disabled. |
| ***Velocity threshold*** | Decimal with fractional part | ≥0 | 1 | The threshold value for velocity calculation. Position pinning will be disabled if this value is reached (in meters per second). Zero values for position and velocity thresholds effectively mean that position pinning is disabled. |
| ***Position update timeout*** | Decimal | >0 | 120 | In position pinning mode, pinned position is updated based on this timeout (in seconds). |
| ***Deep mode delay*** | Decimal | ≥0 | 600 | When in position pinning mode, deep pinning mode is activated after this delay (in seconds). If 0, then deep pinning mode is disabled. |
| ***2D reacquisition*** | Hexadecimal | 0,1 | 0 | Indicates if 2D start-up mode is enabled in reacquisition:<br>0 – disabled,<br>1 – enabled.<br>Please see usage examples below. |

| Name | Format | Valid values | Default value | Description |
|---|---|---|---|---|
| ***2D all*** | Hexadecimal | 0,1 | 0 | Indicates if 2D start-up mode is enabled in all start modes except COLD start:<br>0 – disabled,<br>1 – enabled.<br>Please see usage examples below. |
| ***2D cold*** | Hexadecimal | 0,1 | 0 | Indicates if 2D start-up mode is enabled in COLD start:<br>0 – disabled,<br>1 – enabled.<br>Please see usage examples below. |

In case of successful execution of

**$PUNV,CONFIG,17,*Position threshold*,*Velocity threshold*, *Position update timeout*,*Deep mode delay*,*2D reacquisition 2D all 2D cold**cc**

command the receiver sends confirmation in a following form:

**$PUNV,CFG_S,17*55**

In case of failure of execution of GETCONFIG, CONFIG or SET command the receiver sends ERR reply message. Please see ERR section for details.

Examples:

Default settings:

***$PUNV,CONFIG,17,50,1,120,600,0*cc***

Default settings plus enabling 2D start-up mode for reacquisition only:

***$PUNV,CONFIG,17,50,1,120,600,4*cc***

Default settings plus enabling 2D start-up mode for all start modes only, except COLD start:

***$PUNV,CONFIG,17,50,1,120,600,2*cc***

Default settings plus enabling 2D start-up mode for cold start mode only:

***$PUNV,CONFIG,17,50,1,120,600,1*cc***

Default settings plus enabling 2D start-up mode for all cases:

***$PUNV,CONFIG,17,50,1,120,600,7*cc***

# 4 STANDARD NMEA SENTENCES

Orion supports the following standard NMEA messages: DTM, GGA, GLL, GSA, GSV, RMC, VTG and ZDA.

The following format conventions have been used, in accordance with the NMEA standard:

- When a null field is used to indicate unavailability of data, also the field for the unit of measure is formatted as a null field
- Three digits are always used for decimal-fraction of seconds in UTC time
- Four digits are always used for decimal-fraction of minutes in latitude and longitude
- DTM: Six digits are always used for decimal-fraction of latitude and longitude offsets. Two digits are always used for decimal-fraction of altitude offset.
- GGA: UTC field starts from zero time and changes to measured time when measurement is available (a debugging feature). The number of satellites is always reported with two digits with leading zero when necessary.
- GLL: UTC time field as in GGA
- GSA: satellite ID numbers are in range 0-99. They are always reported with two digits with leading zero when necessary
- GSV: no implementation-specifics
- RMC: UTC time field as in GGA, course and speed over ground as in VTG
- VTG: course over ground is reported with 0.1 degree precision, speed over ground is reported with 0.1 unit precision for both knots and km/h fields. In case of speed equals zero, the heading is reported as null.
- ZDA: Local zone hours are always presented as the user has configured them. The default configuration is 0. The hour zone is reported always by two digits (with leading zero when necessary), and with leading minus sign when necessary. Local zone minutes are always presented with two digits (with leading zero when necessary). UTC time field as in GGA.

# 5 APPENDIX A - DATUM CODES

| ID NMBR | NAME | Region of use |
|---|---|---|
| 0 | "000" | User defined |
| 1 | "WGS84" | Global |
| 2 | "ADI-M" | Ethiopia; Sudan |

| ID NMBR | NAME | Region of use |
|---|---|---|
| 3 | "ADI-E" | Burkina Faso |
| 4 | "ADI-F" | Cameroon |
| 5 | "ADI-A" | Ethiopia |
| 6 | "ADI-C" | Mali |
| 7 | "ADI-D" | Senegal |
| 8 | "ADI-B" | Sudan |
| 9 | "AFG" | Somalia |
| 10 | "AIN-A" | Bahrain |
| 11 | "AIN-B" | Saudi Arabia |
| 12 | "AMA" | American Samoa Islands |
| 13 | "ANO" | Cocos Islands |
| 14 | "AIA" | Antigua (Leeward Islands) |
| 15 | "ARF-A" | Botswana |
| 16 | "ARF-H" | Burundi |
| 17 | "ARF-B" | Lesotho |
| 18 | "ARF-C" | Malawi |
| 19 | "ARF-M" | MEAN FOR Botswana; Lesotho; Malawi; Swaziland; Zaire; Zambia; Zimbabwe |
| 20 | "ARF-D" | Swaziland |
| 21 | "ARF-E" | Zaire |
| 22 | "ARF-F" | Zambia |
| 23 | "ARF-G" | Zimbabwe |
| 24 | "ARS-M" | MEAN FOR Kenya; Tanzania |
| 25 | ARS-A | Kenya |
| 26 | "ARS-B" | Tanzania |
| 27 | "ASC" | Ascension Island |
| 28 | "ATF" | Iwo Jima |
| 29 | "SHB" | St Helena Island |
| 30 | "TRN" | Tern Island |
| 31 | "ASQ" | Marcus Island |
| 32 | "AUA" | Australia; Tasmania |
| 33 | "AUG" | Australia; Tasmania |
| 34 | "PHA" | Djibouti |
| 35 | "IBE" | Efate & Erromango Islands |
| 36 | "BER" | Bermuda |
| 37 | "BID" | Guinea-Bissau |
| 38 | "BOO" | Colombia |
| 39 | "BUR" | Indonesia (Bangka & Belitung Ids) |
| 40 | "CAZ" | Antarctica (McMurdo Camp Area) |
| 41 | "CAI" | Argentina |
| 42 | "CAO" | Phoenix Islands |

| ID NMBR | NAME | Region of use |
|---|---|---|
| 43 | "CAP" | South Africa |
| 44 | "CAC" | Bahamas; Florida |
| 45 | "CGE" | Tunisia |
| 46 | "CHI" | New Zealand (Chatham Island) |
| 47 | "CHU" | Paraguay |
| 48 | "COA" | Brazil |
| 49 | "DAL" | Guinea |
| 50 | "DID" | Deception Island; Antarctica |
| 51 | "BAT" | Indonesia (Sumatra) |
| 52 | "GIZ" | New Georgia Islands (Gizo Island) |
| 53 | "EAS" | Easter Island |
| 54 | "EST" | Estonia |
| 55 | "EUR-E" | Cyprus |
| 56 | "EUR-F" | Egypt |
| 57 | "EUR-G" | England; Channel Islands; Scotland; Shetland Islands |
| 58 | "EUR-K" | England; Ireland; Scotland; Shetland Islands |
| 59 | "EUR-C" | Finland; Norway |
| 60 | "EUR-B" | Greece |
| 61 | "EUR-H" | Iran |
| 62 | "EUR-I" | Italy (Sardinia) |
| 63 | "EUR-J" | Italy (Sicily) |
| 64 | "EUR-L" | Malta |
| 65 | "EUR-M" | MEAN FOR Austria; Belgium; Denmark; Finland; France; W Germany; Gibraltar; Greece; Italy; Luxembourg; Netherlands; Norway; Portugal; Spain; Sweden; Switzerland |
| 66 | "EUR-A" | MEAN FOR Austria; Denmark; France; W Germany; Netherlands; Switzerland |
| 67 | "EUR-S" | MEAN FOR Iraq; Israel; Jordan; Lebanon; Kuwait; Saudi Arabia; Syria |
| 68 | "EUR-D" | Portugal; Spain |
| 69 | "EUR-T" | Tunisia |
| 70 | "EUS" | MEAN FOR Austria; Finland; Netherlands; Norway; Spain; Sweden; Switzerland |
| 71 | "FOT" | Nevis; St. Kitts (Leeward Islands) |
| 72 | "GAA" | Republic of Maldives |
| 73 | "GEO" | New Zealand |
| 74 | "GRA" | Azores (Faial; Graciosa; Pico; Sao Jorge; Terceira) |
| 75 | "GUA" | Guam |
| 76 | "GSE" | Indonesia (Kalimantan) |

| ID NMBR | NAME | Region of use |
|---|---|---|
| 77 | "DOB" | Guadalcanal Island |
| 78 | "HEN" | Afghanistan |
| 79 | "HER" | Croatia -Serbia, Bosnia-Herzegovina |
| 80 | "HJO" | Iceland |
| 81 | "HKD" | Hong Kong |
| 82 | "HTN" | Taiwan |
| 83 | "IND-B" | Bangladesh |
| 84 | "IND-I" | India; Nepal |
| 85 | "IND-P" | Pakistan |
| 86 | "INF-A" | Thailand |
| 87 | "ING-B" | Vietnam (Con Son Island) |
| 88 | "ING-A" | Vietnam (Near 16øN) |
| 89 | "INH-A1" | Thailand |
| 90 | "IDN" | Indonesia |
| 91 | "IRL" | Ireland |
| 92 | "ISG" | South Georgia Islands |
| 93 | "IST" | Diego Garcia |
| 94 | "JOH" | Johnston Island |
| 95 | "KAN" | Sri Lanka |
| 96 | "KEG" | Kerguelen Island |
| 97 | "KEA" | West Malaysia & Singapore |
| 98 | "KUS" | Caroline Islands |
| 99 | "KGS" | South Korea |
| 100 | "LCF" | Cayman Brac Island |
| 101 | "LEH" | Ghana |
| 102 | "LIB" | Liberia |
| 103 | "LUZ-A" | Philippines (Excluding Mindanao) |
| 104 | "LUZ-B" | Philippines (Mindanao) |
| 105 | "MPO" | Gabon |
| 106 | "MIK" | Mahe Island |
| 107 | "MAS" | Ethiopia (Eritrea) |
| 108 | "MER" | Morocco |
| 109 | "MID" | Midway Islands |
| 110 | "MIN-A" | Cameroon |
| 111 | "MIN-B" | Nigeria |
| 112 | "ASM" | Montserrat (Leeward Islands) |
| 113 | "NAH-A" | Oman (Masirah Island) |
| 114 | "NAH-C" | Saudi Arabia |
| 115 | "NAH-B" | United Arab Emirates |
| 116 | "NAP" | Trinidad & Tobago |
| 117 | "NAS-D" | Alaska (Excluding Aleutian Ids) |

| ID NMBR | NAME | Region of use |
|---|---|---|
| 118 | "NAS-V" | Alaska (Aleutian Ids East of 180øW) |
| 119 | "NAS-W" | Alaska (Aleutian Ids West of 180øW) |
| 120 | "NAS-Q" | Bahamas (Except San Salvador Id) |
| 121 | "NAS-R" | Bahamas (San Salvador Island) |
| 122 | "NAS-F" | Canada (Alberta; British Columbia) |
| 123 | "NAS-H" | Canada (Manitoba; Ontario) |
| 124 | "NAS-G" | Canada (New Brunswick; Newfoundland; Nova Scotia; Quebec) |
| 125 | "NAS-I" | Canada (Northwest Territories; Saskatchewan) |
| 126 | "NAS-J" | Canada (Yukon) |
| 127 | "NAS-O" | Canal Zone |
| 128 | "NAS-T" | Cuba |
| 129 | "NAS-U" | Greenland (Hayes Peninsula) |
| 130 | "NAS-P" | MEAN FOR Antigua; Barbados; Barbuda; Caicos Islands; Cuba; Dominican Republic; Grand Cayman; Jamaica; Turks Islands |
| 131 | "NAS-N" | MEAN FOR Belize; Costa Rica; El Salvador; Guatemala; Honduras; Nicaragua |
| 132 | "NAS-E" | MEAN FOR Canada |
| 133 | "NAS-C" | MEAN FOR CONUS |
| 134 | "NAS-A" | MEAN FOR CONUS (East of Mississippi; River Including Louisiana; Missouri; Minnesota) |
| 135 | "NAS-B" | MEAN FOR CONUS (West of Mississippi; River Excluding Louisiana; Minnesota; Missouri) |
| 136 | "NAS-L" | Mexico |
| 137 | "NAR-A" | Alaska (Excluding Aleutian Ids) |
| 138 | "NAR-E" | Aleutian Ids |
| 139 | "NAR-B" | Canada |
| 140 | "NAR-C" | CONUS |
| 141 | "NAR-H" | Hawaii |
| 142 | "NAR-D" | Mexico; Central America |
| 143 | "NSD" | Algeria |
| 144 | "FLO" | Azores (Corvo & Flores Islands) |
| 145 | "OEG" | Egypt |
| 146 | "OHA-A" | Hawaii |
| 147 | "OHA-B" | Kauai |
| 148 | "OHA-C" | Maui |
| 149 | "OHA-M" | MEAN FOR Hawaii; Kauai; Maui; Oahu |
| 150 | "OHA-D" | Oahu |
| 151 | "FAH" | Oman |
| 152 | "OGB-A" | England |
| 153 | "OGB-B" | England; Isle of Man; Wales |

| ID NMBR | NAME | Region of use |
|---|---|---|
| 154 | "OGB-M" | MEAN FOR England; Isle of Man; Scotland; Shetland Islands; Wales |
| 155 | "OGB-C" | Scotland; Shetland Islands |
| 156 | "OGB-D" | Wales |
| 157 | "PLN" | Canary Islands |
| 158 | "PIT" | Pitcairn Island |
| 159 | "PTB" | MEAN FOR Burkina Faso & Niger |
| 160 | "PTN" | Congo |
| 161 | "POS" | Porto Santo; Madeira Islands |
| 162 | "PRP-A" | Bolivia |
| 163 | "PRP-B" | Chile (Northern; Near 19øS) |
| 164 | "PRP-C" | Chile (Southern; Near 43øS) |
| 165 | "PRP-D" | Colombia |
| 166 | "PRP-E" | Ecuador |
| 167 | "PRP-F" | Guyana |
| 168 | "PRP-M" | MEAN FOR Bolivia; Chile; Colombia; Ecuador; Guyana; Peru; Venezuela |
| 169 | "PRP-G" | Peru |
| 170 | "PRP-H" | Venezuela |
| 171 | "HIT" | Chile (Near 53øS) (Hito XVIII) |
| 172 | "PUR" | Puerto Rico; Virgin Islands |
| 173 | "PUK" | Russia |
| 174 | "QAT" | Qatar |
| 175 | "QUO" | Greenland (South) |
| 176 | "REU" | Mascarene Islands |
| 177 | "EUR-I" | Italy (Sardinia) |
| 178 | "SPK-A" | Hungary |
| 179 | "SPK-B" | Poland |
| 180 | "SPK-C" | Czechoslovakia |
| 181 | "SPK-D" | Latvia |
| 182 | "SPK-E" | Kazakhstan |
| 183 | "SPK-F" | Albania |
| 184 | "SPK-G" | Romania |
| 185 | "CCD" | Czechoslovakia (Prior 1 JAN 1993) |
| 186 | "SAE" | Espirito Santo Island |
| 187 | "SAO" | Azores (Sao Miguel; Santa Maria Ids) |
| 188 | "SAP" | East Falkland Island |
| 189 | "SCK" | Namibia |
| 190 | "SGM" | Salvage Islands |
| 191 | "SRL" | Sierra Leone |
| 192 | "SAN-A" | Argentina |
| 193 | "SAN-B" | Bolivia |

| ID NMBR | NAME | Region of use |
|---|---|---|
| 194 | "SAN-C" | Brazil |
| 195 | "SAN-D" | Chile |
| 196 | "SAN-E" | Colombia |
| 197 | "SAN-F" | Ecuador |
| 198 | "SAN-J" | Ecuador (Baltra; Galapagos) |
| 199 | "SAN-G" | Guyana |
| 200 | "SAN-M" | MEAN FOR Argentina; Bolivia; Brazil; Chile; Colombia; Ecuador; Guyana; Paraguay; Peru; Trinidad & Tobago; Venezuela |
| 201 | "SAN-H" | Paraguay |
| 202 | "SAN-I" | Peru |
| 203 | "SAN-K" | Trinidad & Tobago |
| 204 | "SAN-L" | Venezuela |
| 205 | "SOA" | Singapore |
| 206 | "TAN" | Madagascar |
| 207 | "TIL" | Brunei; E. Malaysia (Sabah Sarawak) |
| 208 | "TOY-A" | Japan |
| 209 | "TOY-M" | MEAN FOR Japan; South Korea; Okinawa |
| 210 | "TOY-C" | Okinawa |
| 211 | "TOY-B" | South Korea |
| 212 | "TDC" | Tristan da Cunha |
| 213 | "MVS" | Fiji (Viti Levu Island) |
| 214 | "VOR" | Algeria |
| 215 | "WAK" | Wake Atoll |
| 216 | "ENW" | Marshall Islands |
| 217 | "WGS72" | Global Definition |
| 218 | "YAC" | Uruguay |
| 219 | "ZAN" | Suriname |
| 220 | – | Reserved |
| 221 | "KKJ" | Finland |